

# The Benefits & Risks of Animals Living with Immunocompromised Patients

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12/2/2022

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# Objectives

- Review some infections that can be caused by animals in patients who are immunosuppressed
- Review the risks of zoonotic diseases, especially in immunocompromised host patients with particular focus paid to solid organ transplant recipients
- Discuss preventive measures in patients who have an immunocompromised condition and are in contacts with animals

- Credits: Much of this talk is based on prior lectures by Alejandro Restrepo and Laila Woc-Colburn

# Conflicts of interest

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# Motivational case

- 61 year old male with a history of end stage renal disease underwent living unrelated kidney transplant in September 2016
- Post-operative course complicated by *C. difficile* colitis as well as both antibody and cellular rejection treated with steroids, plasmapheresis, thymoglobulin, IVIG, rituximab, and eculizumab.

# Motivational case

- Subsequently, he presented one year post-transplant with several days of fevers to 101.5 without localizing symptoms.
- Chemistries demonstrated AST 108 U/L and ALT 93 U/L.
- Hepatitis workup, CMV PCR, EBV PCR, and respiratory virus panel were all unremarkable. CT of the abdomen and pelvis did not reveal a source. His fevers resolved and he was discharged without a specific diagnosis.

# Motivational case

- On post-discharge follow up later that month, he noted the recurrence of low grade fevers up to 100.4 F, and he was noted to have lost ten pounds. He also noted sporadic headaches.
- Next steps?

# Motivational case

HHV 6 PCR            negative

Galactomannan    negative

Adenovirus PCR    negative

Cryptococcal Ag    negative

AFB blood            negative

HIV PCR             negative

# Motivational case

- His blood was sent for whole genome sequencing (Karius Diagnostics, California, USA).

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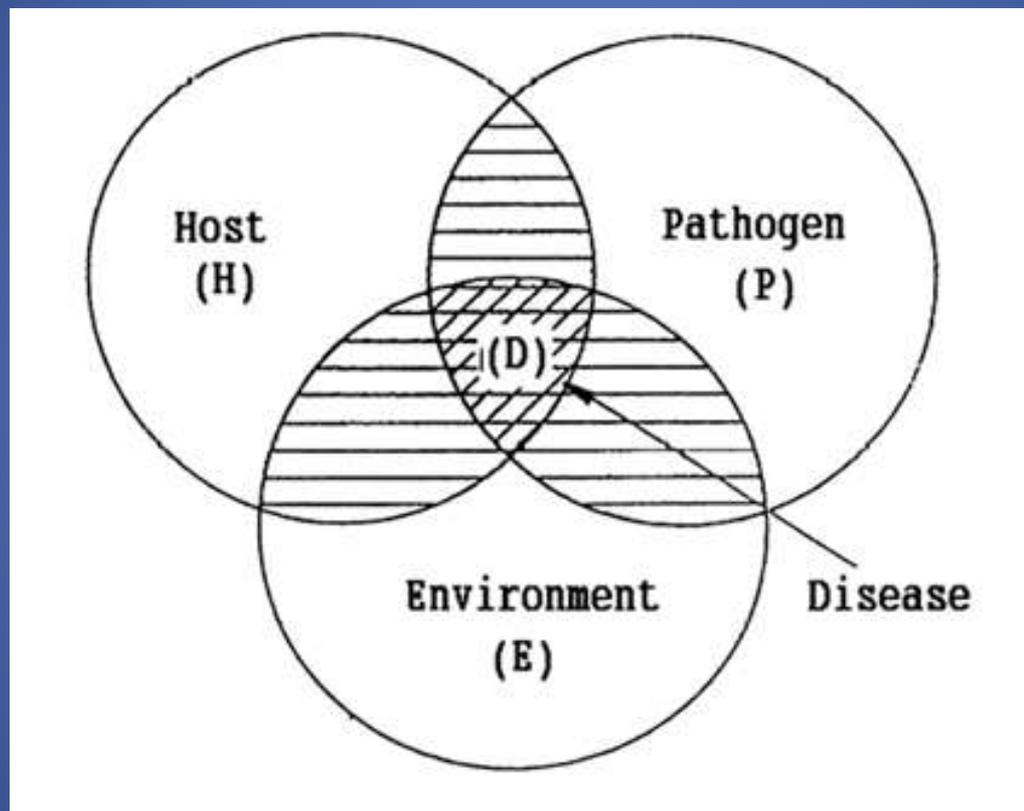
**MICROORGANISM(S) DETECTED AT STATISTICALLY SIGNIFICANT LEVELS**

**Bartonella henselae**

**Torque teno virus**

# Motivational case

- Subsequent antibody testing was confirmatory with Bartonella IgG 1:512 with negative IgM.
- The patient stated that there were two cats in the home, but he never fed them or cleaned their waste products.
- Transthoracic echocardiogram was negative for vegetations, and his fevers resolved with a 4 week course of doxycycline. He did not return for ID follow up as he was feeling well and his symptoms had resolved.



Svobodová Z. Lloyd R. Máchová J. Vykusová B. Water quality and fish health. EIFAC Technical Paper. No. 54. Rome, FAO. 1993.

# Pets and immunocompromised patients

**Table 5.1** Proportion of households reporting pet animal ownership by country.

Region/country	Any pet*	Dog*	Cat*	Other*
Africa				
Zimbabwe <sup>1</sup>	NR	62.0	NR	
Australia <sup>2,3</sup>	63	37.8	25.0-25.8	Cat and/or dog (53)
Europe				
Ireland <sup>4</sup>	NR	35.6	10.4 <sup>†</sup>	
Italy <sup>5</sup>	46	32.7	15.1	
United Kingdom <sup>6,7</sup>	NR	23-30.6	19-25.5	Indoor fish (10), rabbit (2.6), indoor bird (2.5), guinea pig (1.6), hamster (1.1), horse (0.5), turtle (0.9), gerbil (0.3), snake (0.4), lizard (0.5), rat (0.3)
North America				
Canada <sup>8,9</sup>	56 (cat or dog)	30-32.3	28-35.5	Fish (12), bird (5), rabbit (2), hamster (2), lizard (1), horse (1), guinea pig (1), snake (1), frog (1), turtle (1), ferret (1), gerbil (1)
United States <sup>10</sup>	NR	37.2	32.4	Bird (3.9), horse (1.8)
South America				
Brazil (São Paulo) <sup>11</sup>	NR	52.5	NR	

\* Proportion reporting owning one or more.

† Does not include outdoor only.

NR Not measured in the study.

# Benefits of having a pet

- Despite the risk of infection from animals, many benefits of pet ownership have been shown
  - Psychological
  - Increased exercise
- Analysis of data from the CAST trial showed that social support and pet ownership were independent predictors of survival one year after MI

# Benefits of having a pet

**TABLE II** One-Year Survival Status According to Pet, Dog, and Cat Ownership (n = 369)

Ownership Status	One-Year Survival Status		Chi-Square
	Survived (number of subjects)	Died (number of subjects)	
No pets	246	16	1.07
Pets	103	4	
No dogs	263	19	4.05*
Dogs	86	1	
No cats	308	17	0.19
Cats	41	3	

\*p <0.05.

*Vet Clin North Am Small Anim Pract.* 2009 Mar;39(2):293-326.

*Am J Cardiol.* 1995 Dec 15;76(17):1213-7.

# Benefits of having a pet

- Data in immunocompromised patients primarily derives from HIV-related studies
- Large cohort studies such as the Multicenter AIDS Cohort Study as well as smaller studies have documented the psychological benefits of pet ownership in patients with advanced HIV
- Data specifically from transplant patients are lacking

Psychol Rep. 2001 Aug;89(1):177-87.

AIDS Care. 1999 Apr;11(2):157-70.

# Benefits of having a pet

- Transplant recipients frequently have pets without transmission of infection
- Published literature is biased. There are no reports of the number of transplant patients who safely maintain pets in their household

# Transmission from pets



# Transmission from pets

- Saliva that contaminate bite wounds, skin abrasions, or mucous membranes
- Hand to mouth transfer (ex: from feces of an infected animal)
- Insect bites (vector are carried by pets or as a reservoir)
- Scratches
- Aerosol from body fluids
- Contamination of water or the environment (animal urine)

# Zoonosis associated with dogs

- Rabies (developing countries)
- *Pasteurella spp*
- *Capnocytophaga*
- *Toxocara canis*
- *Echinococcus*
- *Dipylidium caninum*



# Zoonosis associated with dogs



# Zoonosis associated with dogs

- Dogs can transport ticks and fleas
  - *Lyme*
  - *Ehrlichia*
  - *Babesia*
  - *Tularemia*
  - *Rickettsia rickettsii*

# Zoonoses associated with dogs

- *Bordetella bronchiseptica* (“kennel cough”). Esp. reports in lung transplant recipients
- Leishmaniasis
- Leptospirosis
- Brucella
- *Salmonella, Campylobacter, cryptosporidium, Giardia*
- *Ancylostoma caninum* and *A. braziliense*





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## REASONS WHY CATS ARE JERKS

# Zoonoses associated with cats

- *Bartonella henselae*
- *Capnocytophaga*
- *Pasteurella spp*
- *Toxocara cati*
- *Toxoplasma gondii*
- *Ancylostoma braziliense*
- *Sporothrix schenckii*
- *Microsporium canis*
- *Salmonella, Campylobacter*
- *Cryptosporidium, Giardia*



Gerhold RW, Jessup DA. Zoonotic diseases associated with free-roaming cats. *Zoonoses Public Health* 2013; 60:189.

# SOT patients with Bartonella frequently manifest disseminated disease

Patient (Ref.)	Age/Sex (yr)	Txp Organ	Interval From Txp to Infection	Type/Site of Infection	Definite or Probable Case	Therapy	Therapy Duration	Outcome
1 (19)	7/M	Kidney	4 yr	CSD	Prob	Gent, T/S	4 wk	Cure
2 (55)	19/F	Kidney	8 yr	CSD	Def	Azith	7 mo	Cure
3 (9)	62/F	Liver	9 mo	CSD	Def	Levo, azith	6 mo	Cure
4 (34)	56/M	Kidney	5 yr	CSD	Prob	Clarith	3 mo	Cure
5 (31)	17/M	Kidney	1 wk	CSD	Def	NA	NA	NA
6 (51)	26/F	Kidney	11 mo	CSD	Prob	Levo	NA	Cure
7 (8)	34/M	Kidney	14 yr	CSD	Prob	T/S, tobra, eryth	4 wk	Cure
8 (PR)	39/F	Kidney	12 yr	CSD	Prob	Azith	8 mo	Cure
9 (10)	28/M	Kidney	12 yr	Diss	Def	Eryth, cipro	3 mo	Cure
10 (25)	13/M	Kidney	3.5 yr	Diss	Prob	Cipro	NA	Cure
11 (9)	51/M	Liver	6 mo	Diss	Prob	Azith, doxy	2 mo	Cure
12 (4)	12/M	Liver	11 mo	Diss	Prob	Gent	2 wk	Cure
13 (19)	9/F	Kidney	27 mo	Diss	Prob	Gent, doxy	2 mo	Cure
14 (19)	8/F	Kidney	3 yr	Diss	Prob	Doxy, T/S	NA	Cure
15 (28)	44/F	Liver	4 yr	Diss	Prob	Azith	1 mo	Cure
16 (11)	19/F	Liver	16 mo	Diss	Def	Doxy	2 mo	Cure
17 (3)	25/M	Kidney	2 yr	Diss	Def	Eryth	3 mo	Cure
18 (61)	52/F	Liver	32 mo	Diss	Def	Doxy	3 mo	Cure
19 (42)	16/F	Kidney	18 mo	Diss	Def	Doxy	2 wk	Cure
20 (16)	24/M	Kidney	1 yr	Diss	Prob	Doxy, eryth	12 mo	Cure
21 (33)	38/F	Heart	5 yr	Diss	Prob	Doxy, eryth	2 mo	Cure
22 (60)	44/F	Kidney	5 yr	Diss	Def	Eryth	4 wk	Cure
23 (50)	55/F	Kidney	2 yr	Diss	Prob	Cipro	3 mo	Cure
24 (44)	39/F	Lung	2 yr	Diss	Def	Clarith, rif, cipro, doxy	Lifelong	Cure
25 (59)	8/M	Liver	2 mo	Diss	Def	T/S, amik, azith	2 mo	Cure
26 (PR)	50/M	Kidney	1 mo	Diss	Def	Levo, doxy, azith	4 mo	Cure
27 (PR)	51/M	Kidney	4 yr	Diss (IE)	Prob	Ceftriax, doxy	6 wk	Died
28 (PR)	57/M	Liver	17 mo	Diss (IE)	Prob	Ceftriax, doxy, gent	1 wk	Died
29 (PR)	63/M	Kidney	10 yr	Diss	Def	Azith, doxy	4 mo	Cure

Abbreviations: CSD = cat scratch disease, Diss = disseminated disease, IE = infective endocarditis, NA = not available, PR = present report, Txp = transplant, Def = definite infection, Prob = probable infection, amik = amikacin, azith = azithromycin, ceftriax = ceftriaxone, cipro = ciprofloxacin, clarith = clarithromycin, doxy = doxycycline, eryth = erythromycin, gent = gentamicin, levo = levofloxacin, rif = rifampin, tobra = tobramycin, T/S = trimethoprim/sulfamethoxazole.

# Cats are a significant vector for murine typhus

- One study in Los Angeles found that 9/10 cats living in houses with murine typhus cases were seropositive for *R. typhi*, vs 42% of possums living in the vicinity of human cases of murine typhus.
- A study in Austin found that 18% of cats, 44% of dogs, and 71% of opossums near cases were *R. typhi* seropositive

Sorvillo FJ, Gondo G, Emmon R, et al. A suburban focus of endemic typhus in Los Angeles County: association with seropositive domestic cats and opossums. *Am J Trop Med Hyg*, 1993, vol. 48 (pg. 269-73).

Adjemian J et al. Murine typhus in Austin, Texas, USA, 2008. *Emerg Infect Dis*. 2010 Mar;16(3):412-7.

# Fungal zoonoses acquired from cats

- *Sporothrix schenckii*



<http://vetbook.org>

- *Microsporum canis*



<http://fixnation.org>

Gerhold RW, Jessup DA. Zoonotic diseases associated with free-roaming cats. Zoonoses Public Health 2013; 60:189.

# Mycobacterial zoonoses acquired from cats

- *Mycobacterium bovis*



Gerhold RW, Jessup DA. Zoonotic diseases associated with free-roaming cats. *Zoonoses Public Health* 2013; 60:189.

# Other infections caused by animals

- Type of pet and specific risks for infections
  - Reptiles (snakes, iguanas, lizards and turtles): high risk of *Salmonella* infection and other GI pathogens
  - Chicks, ducklings: *Salmonella* infections
  - Monkeys: risk for *Shigella* and esp B virus infection(encephalomyelitis)



# Other infections caused by animals

- Goat, cattle, sheep: infection due to *Coxiella burnetti* (Q fever), parapoxvirus (skin lesions)
- Bats, raccoons, skunks, foxes, and coyotes: reservoir of rabies virus (infected saliva)
- Fish: can cause *mycobacterium marinum* “fish tank granuloma”. Also *M. fortuitum* and *M. chelonae*



# Other infections

- Rabbits: *Bordetella bronchiseptica*, tularemia
- Rodents (hamsters, guinea pigs, mice, rats): risk of lymphocytic choriomeningitis virus (LCMV)
- Rats, mice: Rat bite fever (*streptobacillus moniliformis* or *Spirillum minus*), leptospirosis



# Other infections

- Birds : transmit infections like avian influenza and cryptococcosis (pigeons and chickens)
- Birds (parrots, parakeets, cockatoos: psittacosis (*C. psittaci*))
- Horses: risk for *rhodococcus equi* infections, salmonella, campylobacter



# Other infections

Dear all,

I wanted to ask your opinion regarding a pre liver transplant patient who has several tropical **birds** (parrots etc.) at home and she refuses to get rid of them. Transplant hepatology has held her listing for a liver transplant for this reason.

Would you not offer her a liver transplant because of her pet **birds**? Or can she still get transplanted with any special instructions/restrictions?

Thank you very much for your input!

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Thank you very much for your input!

We would push for removal of the **birds** (we've had some success with encouraging patients to find a friend to adopt the **bird**) at the time of transplant. We've had a death due to Cryptococcus after transplant in a patient who refused to give up the **birds**...

Best wishes,

Personal communication

# Safe living after SOT

- Goal of transplantation is to be able to lead as healthy and normal a life as possible (the risk of exposure to infectious agents will always be present)
- Measures can be taken to reduce high-risk epidemiologic exposures (hospital and/or community)
- Immunocompromised patients should be counseled in ways to minimize the risk of infection
- Most organisms are acquired from direct contact (particularly on hands or from fomites), ingestion, or inhalation

# Barriers to safe living after SOT

- The general population is unaware that pets can be a source of infection to humans
- Data from the HIV literature would suggest that physicians do not adequately assess pet ownership and counsel patients about strategies to avoid infection
- Furthermore, many physicians believe that educating patients about zoonoses is the responsibility of veterinarians, while most veterinarians are unaware of the immune status of pet owners.

Anthrozoös 1989: 3(1): 45-49.

AIDS. 2003 Jun 13;17(9):1404-6.

Emerg Infect Dis. 1999 Jan-Feb;5(1):159-63.

# Barriers to safe living after SOT

Question	Veterinarians		Physicians		$\chi^2$
	N	%	N	%	
How many immune compromised patients do you see in your office per week?					
0-10			77	69.4	
11-20			20	18.0	
21-50			6	5.4	
> 50			8	7.2	
How many times have you discussed zoonotic diseases with clients/immune-compromised patients?					146.35*
0	0		79	66.9	
1-3	9	10.7	31	26.3	
4-10	14	16.7	5	4.2	
> 10	61	72.6	3	2.5	
How many times have you discussed the risks of pet ownership with clients/immune-compromised patients?					92.53*
0	11	13.1	79	66.9	
1-3	18	21.4	33	28.0	
4-10	15	17.9	3	2.5	
> 10	40	47.6	3	2.5	
Do you have brochures in your office that address pet-related zoonoses or risk to your immune-compromised clients/patients?	32	38.1	5	4.2	37.60*
Have you ever visited a website to explore zoonotic risks to immune-compromised clients/patients?	17	20.2	5	4.2	12.96*

\* $P < 0.001$ .

# Prevention

- Hand washing (soap & water)
- Hygienic hand rubs (except when visible soil in hands seen)
- Gloves are helpful
- Barefoot walking outside should be avoided
  - Toxocara (dog roundworm) eggs in one study were found in 66% of parks in the Bronx



Tyungu D, *et al.* Preliminary results of city-wide geo-surveillance study of *Toxocara* sp in parks and playgrounds of NYC. IDWeek 2016, New Orleans.

# Prevention



- Food safety (milk products, fruits/seafood, vegetables, raw food/eggs, raw poultry, meat, fish)
- Counseling transplant recipients who work with animals (veterinarians, pet store employees, farmers, slaughterhouse or laboratory workers)
- Waiting to acquire a new pet until the patient is on a stable immune suppression regimen (at least 6–12 months after transplantation)

# Prevention

- Avoid contact with animals that have diarrhea
- Keep pets healthy (avoid contaminated or spoiled food)
- Seek veterinary help at the first signs of illness
- Wash hands carefully after handling pets
- Avoid cleaning bird cages, bird feeders, litter boxes, and handling animal feces (If this is not possible, use gloves and surgical mask)

# Prevention

- Avoid stray animals (do not pet stray animals)
- Avoid animal bites and scratches
- Ensure that areas near the home are free of raccoon latrines
- Avoid contact with non-human primates (monkeys)
- Wear gloves to clean aquariums or have someone else in household do the cleaning

# Further information

<https://www.cdc.gov/healthypets/specific-groups/organ-transplant-patients.html>

# Questions?

- [vahemmig@montefiore.org](mailto:vahemmig@montefiore.org)

